X-Band Work in Fermilab Technical Division: Status Report and Future Plans

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Fermilab
Technical Division

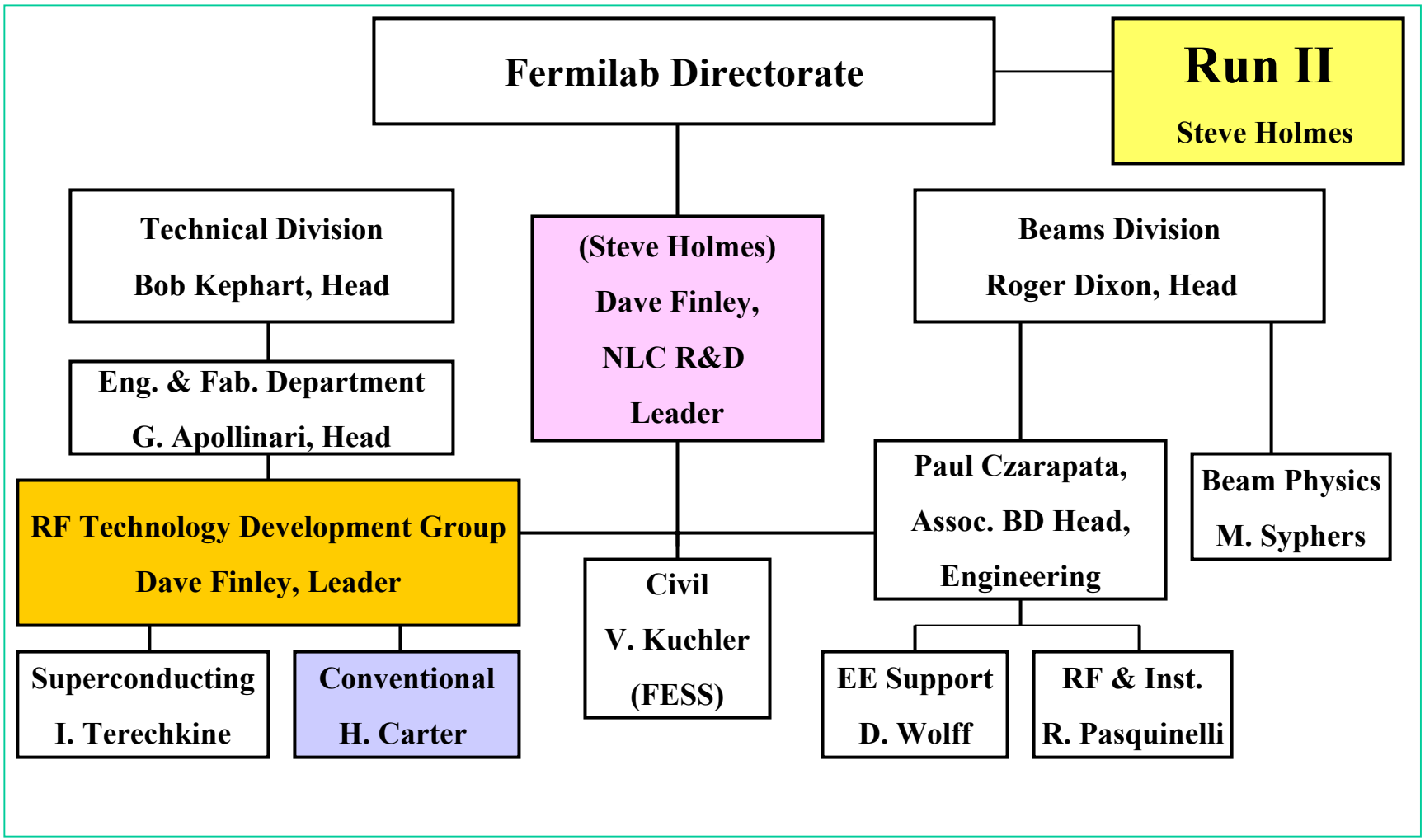
Outline

- Mission
- Organization
- Work Accomplished
- Future Plans
- Summary

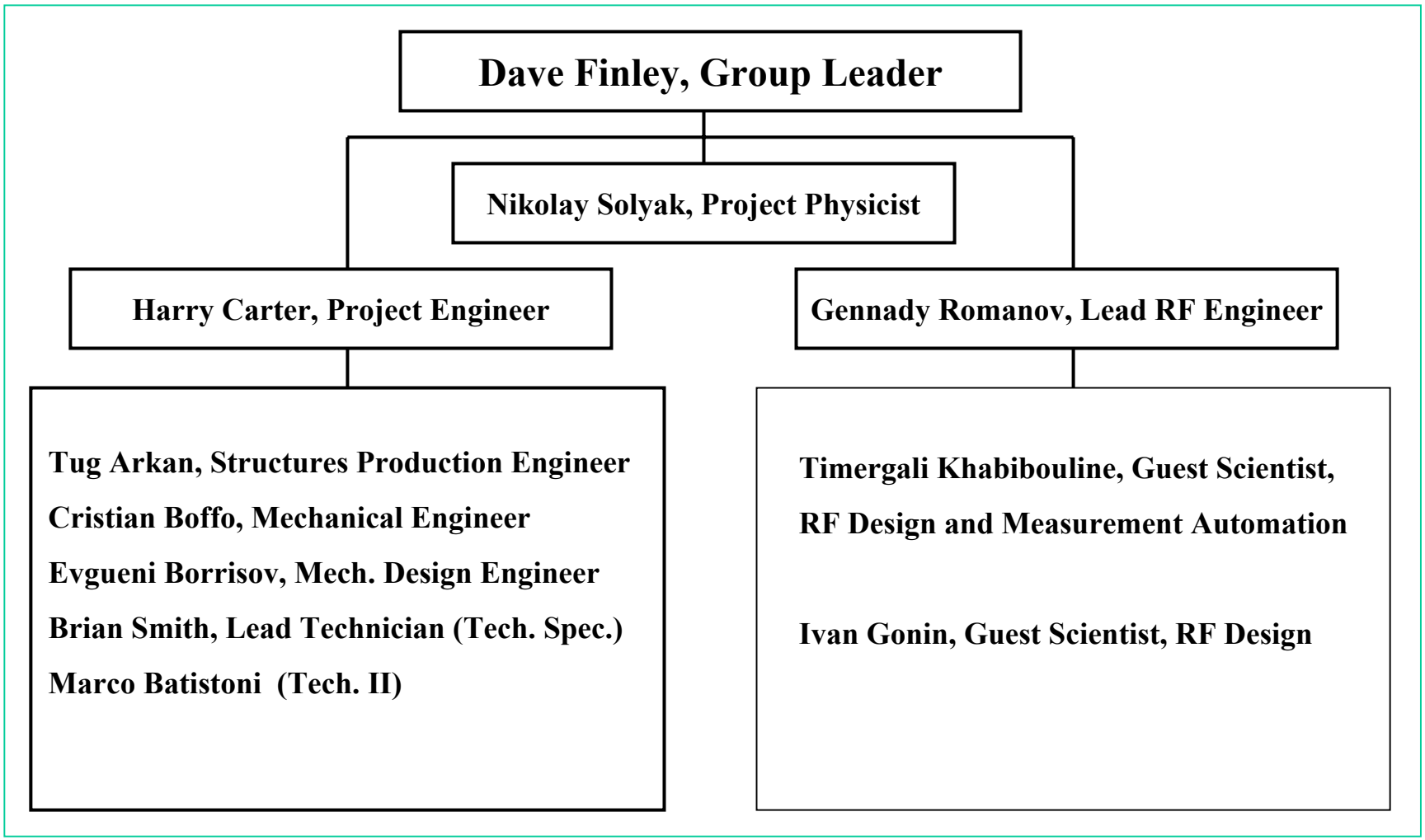
Mission

- **Original mission was to develop industrialization of the structure manufacturing process. This included:**
  - **Developing vendors to supply structure component parts**
  - **Developing vendors to supply assembled structures**
- **Our mission has evolved into the above, plus as a higher priority, we are to supply test structures in support of the Eight Pack Program at SLAC**

Organization: NLC Collaboration at Fermilab



RF Technology Development (Conventional) Group
Personnel & Responsibilities



Work Accomplished

- Structure Production
- RF Design, Development & Testing
- Girder Development & Testing
- “Special” Projects

Work Accomplished: Structure Production

- We have produced three 20 cm. long traveling wave structures: FXA-001, FXA-002, and FXA-003.
- We have produced two 60 cm. long high gradient structures: FXB-002 and FXB-003
- We have produced several 60 cm. long "dummy" structures for girder and assembly tests
- We are continuing to improve our fabrication methods and processes
- We are working to broaden our base of vendors capable of producing high precision machined parts (2 for disks and 3 for couplers) for structures

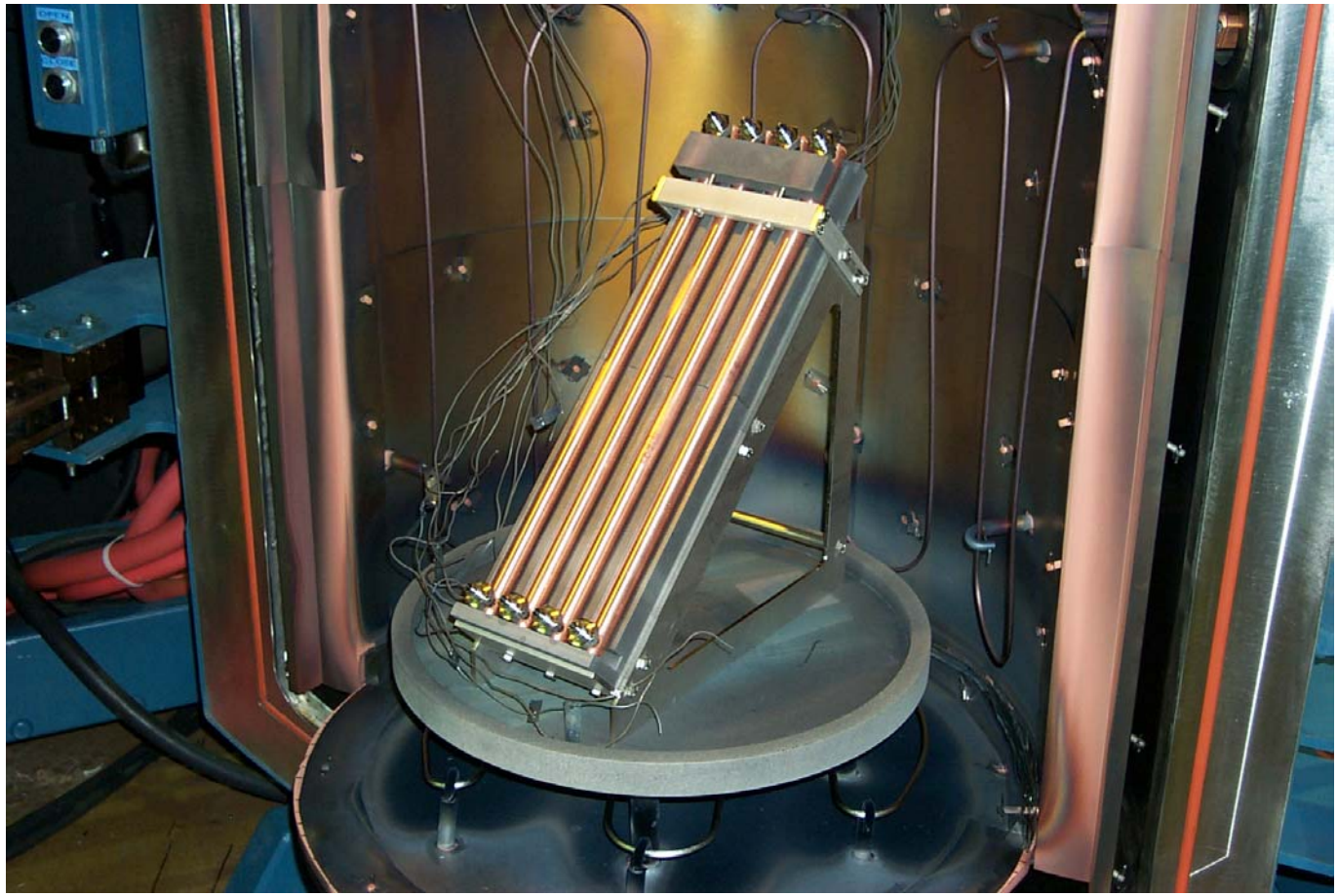
FXA-001

Work Accomplished: Structure Production

FXB-002

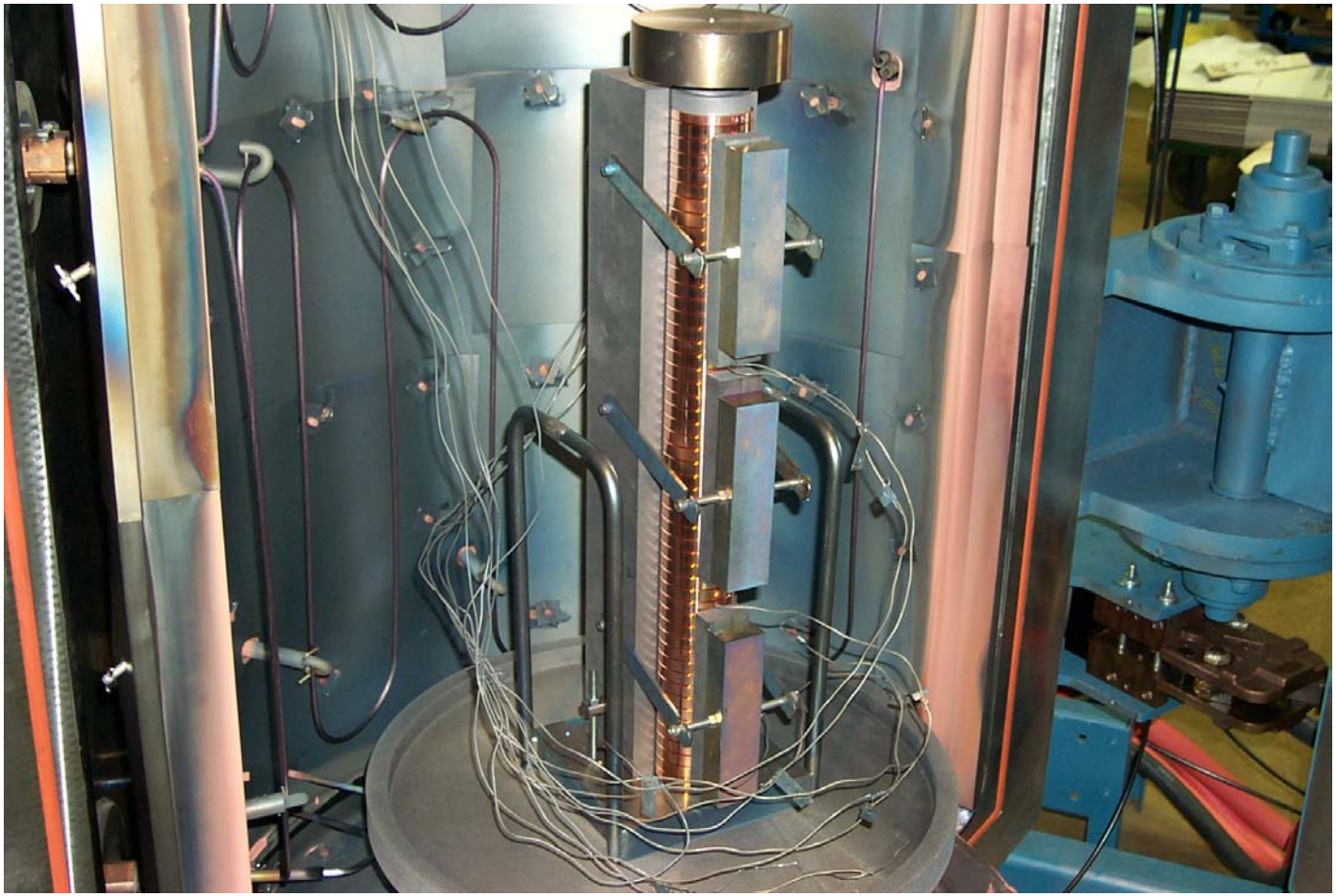
Work Accomplished: Structure Production

Water Tubes Ready for Brazing in Large Vacuum Furnace



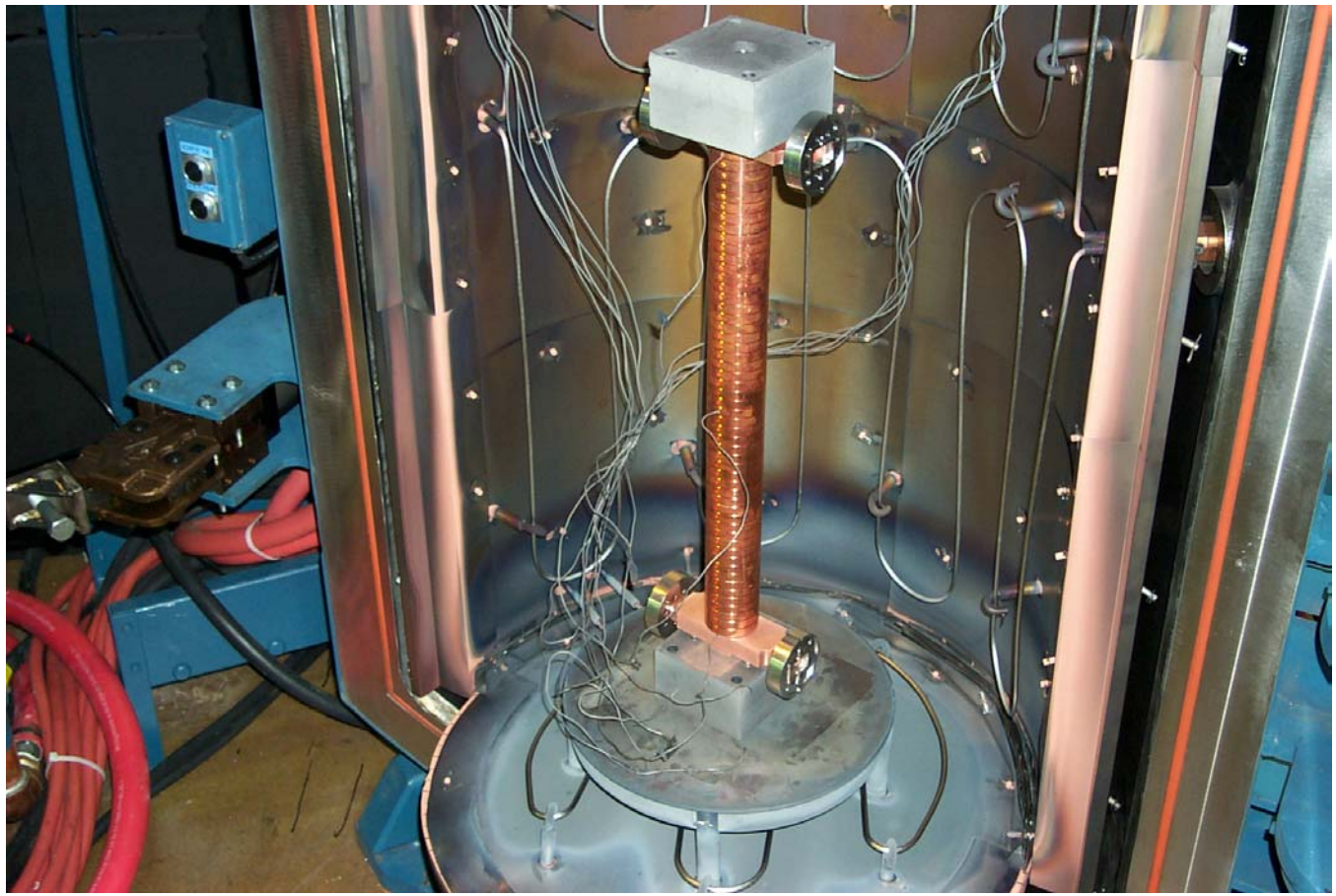
Work Accomplished: Structure Production

Dummy Structure Disk Stack Assembly in Large Vacuum Furnace



Work Accomplished: Structure Production

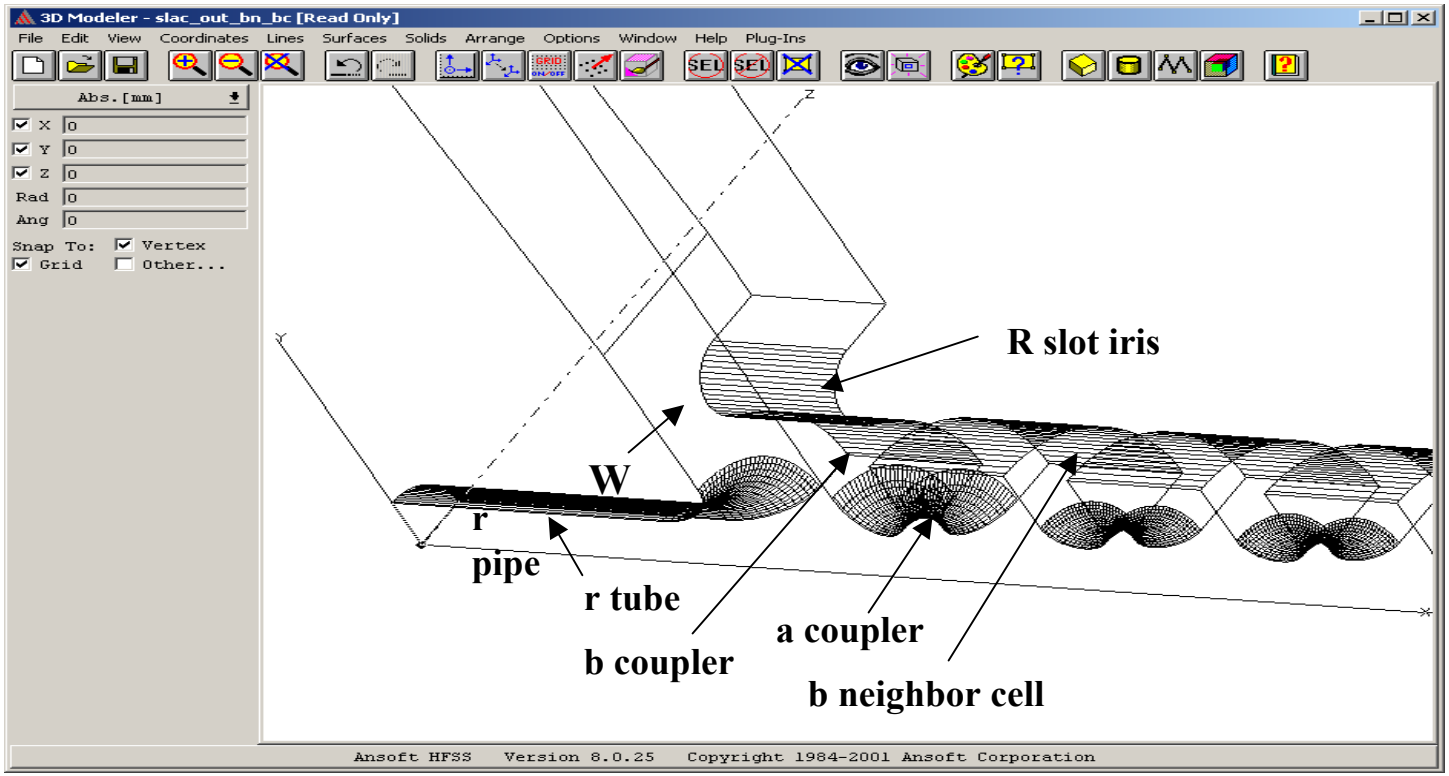
Dummy Structure Coupler-to-Disk Stack Assembly in Large Vacuum Furnace



Work Accomplished: RF Design & Testing

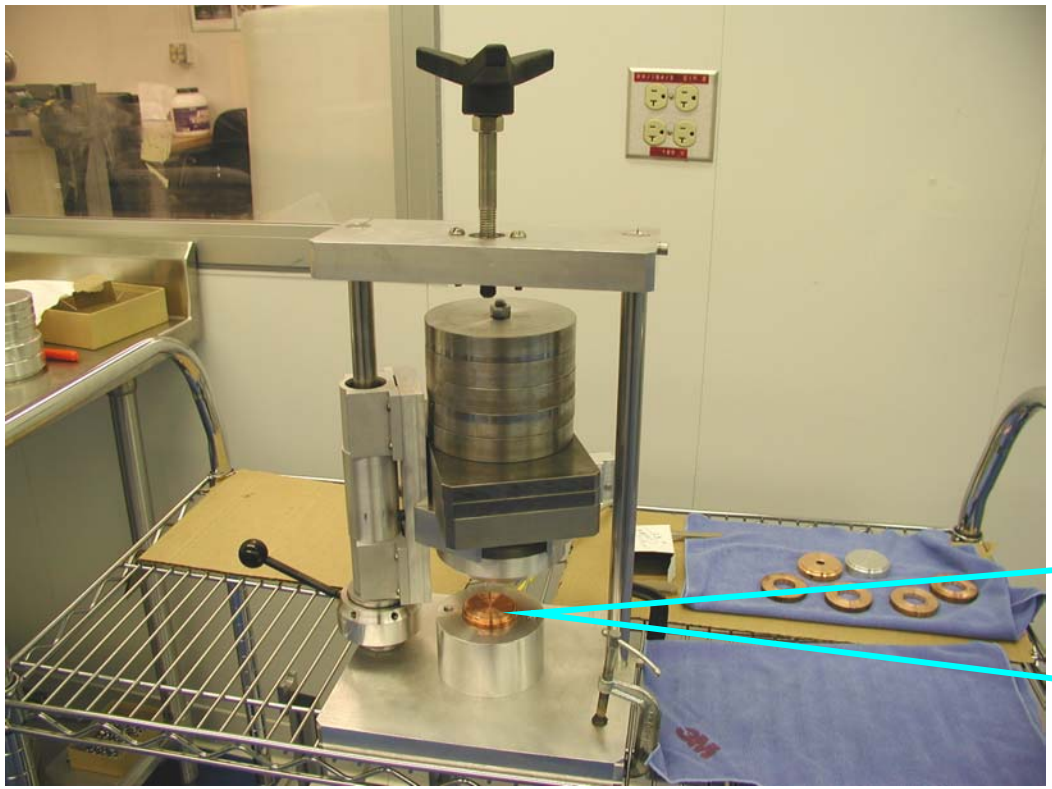
- **We have improved our "in-house" RF design capabilities through the purchase of more powerful software and hardware and through collaboration with our SLAC and KEK colleagues.**

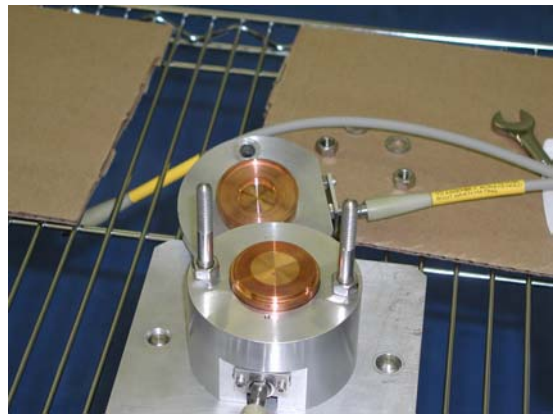
3D Model of FNAL Designed Coupler

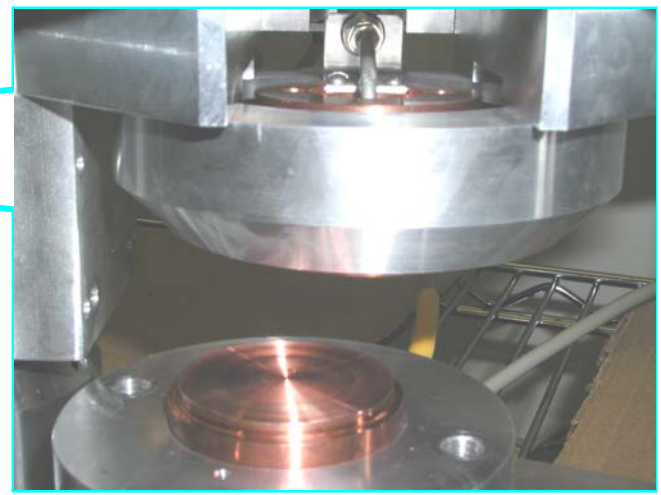


Work Accomplished: RF Testing

We conduct single cell measurements using a special fixture

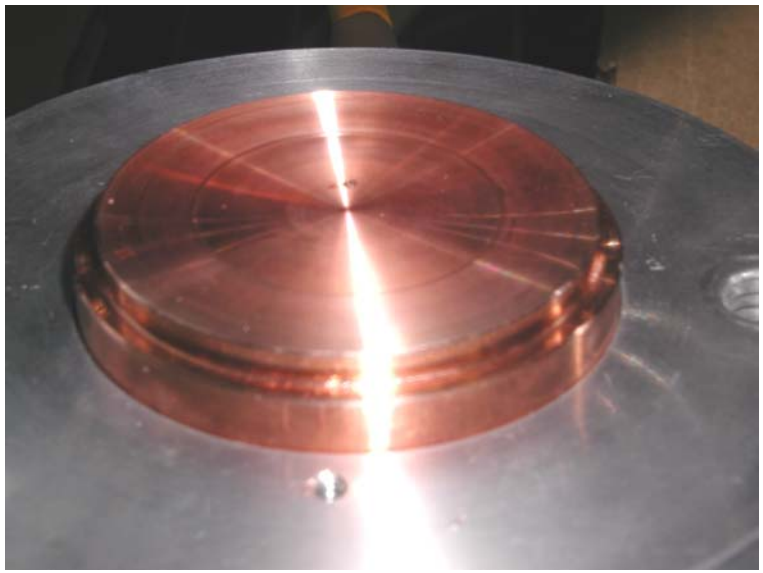




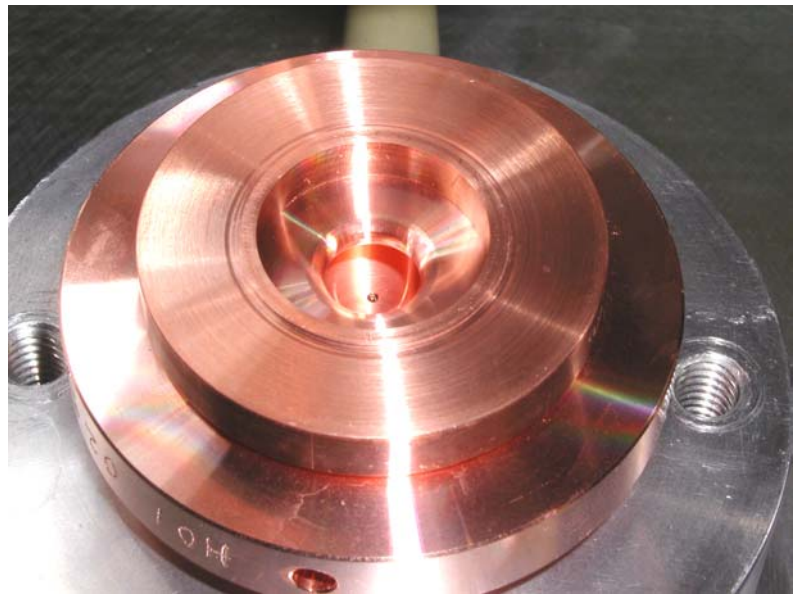


Work Accomplished: RF Testing

Single Disk QC Set-Up

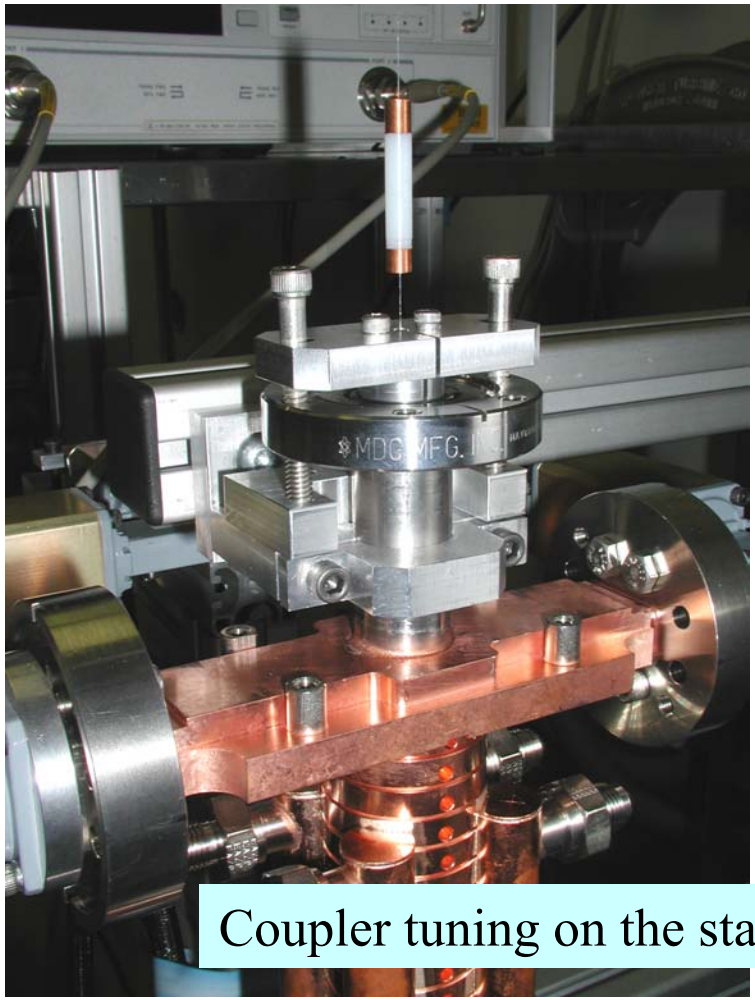


Ground-block

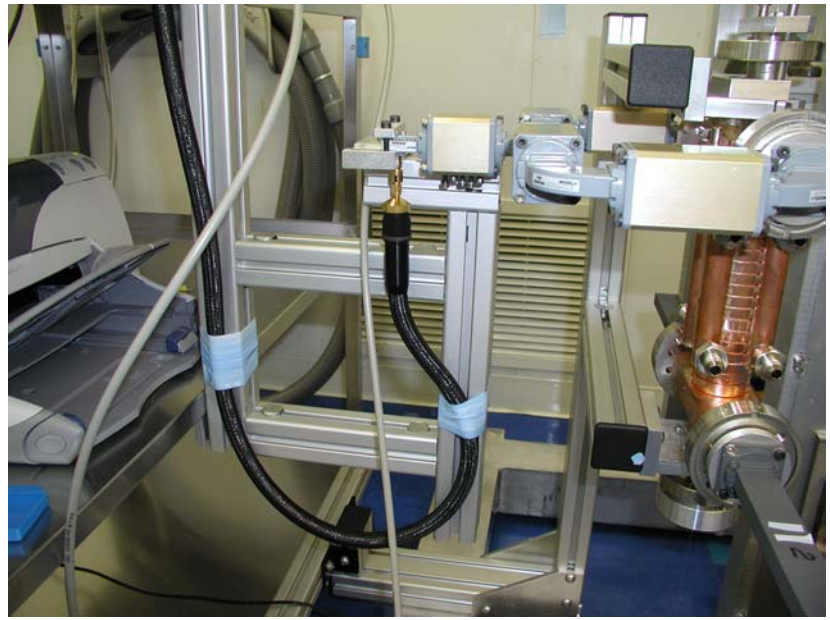


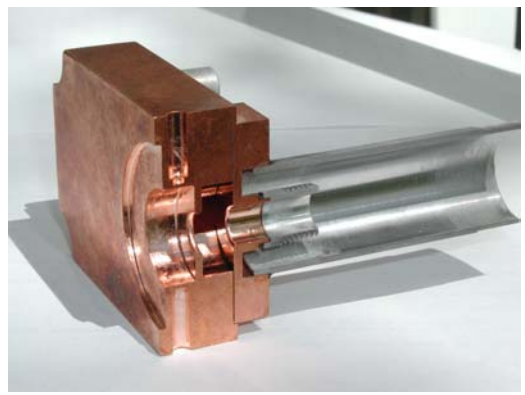
FXB-001 disk and half-cell

Work Accomplished: RF Testing/Bead-pull Measurements



Coupler tuning on the stand





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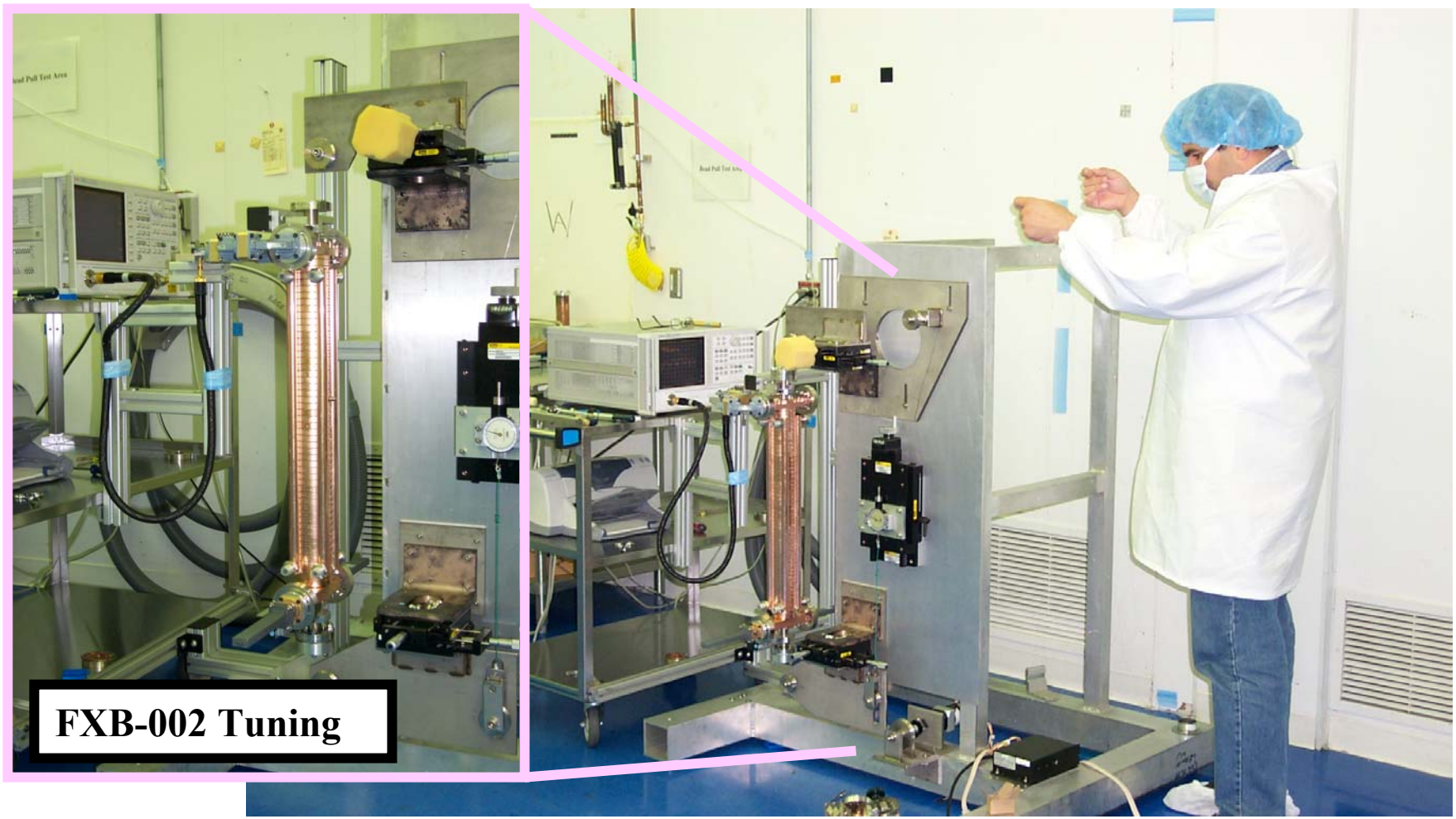

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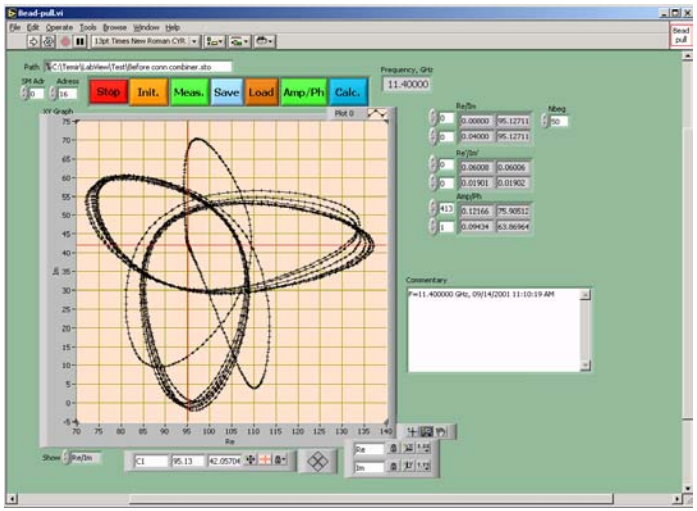
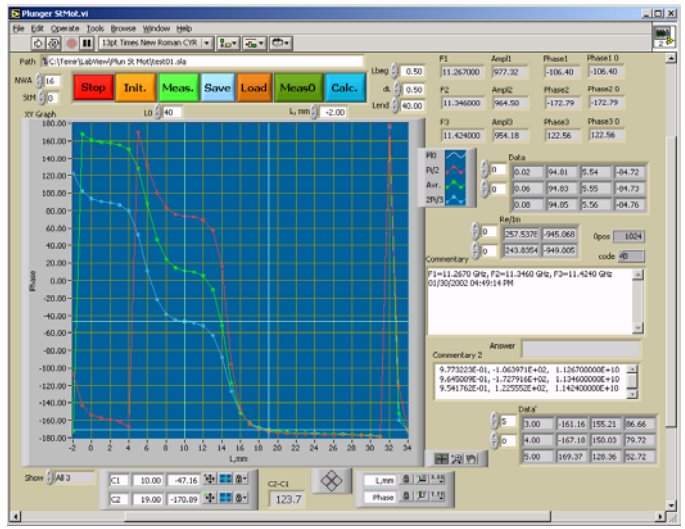
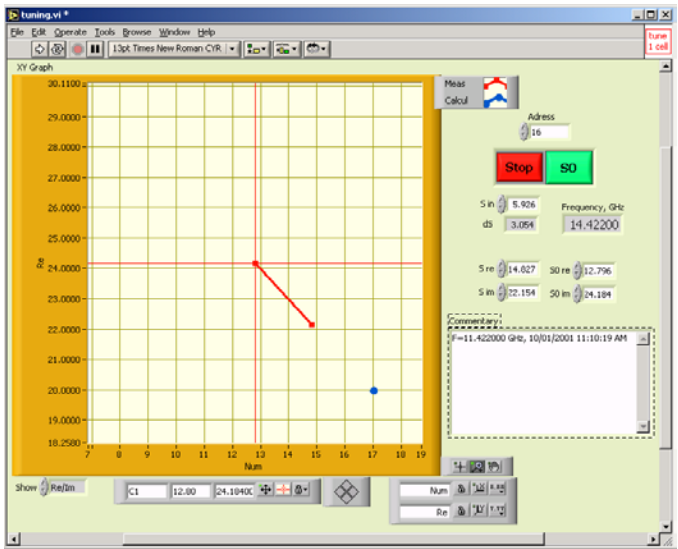
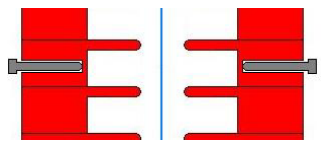
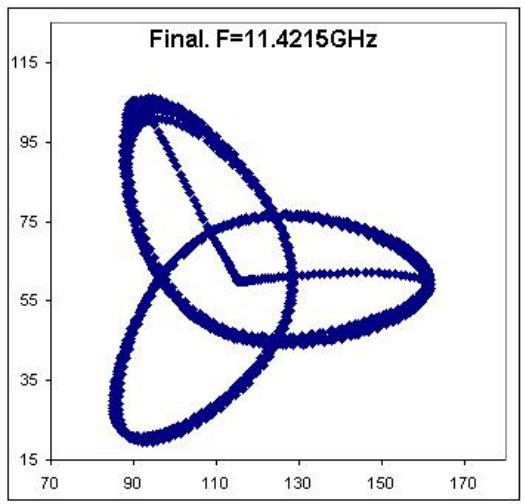






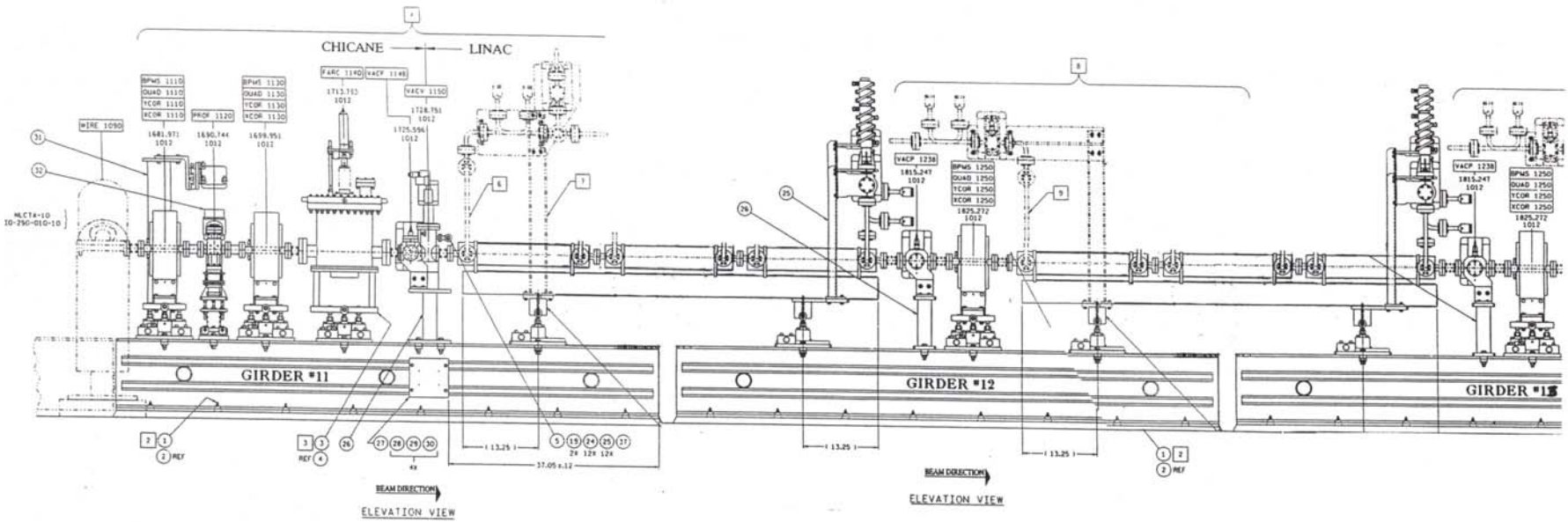
FXA Series Structure Tuning





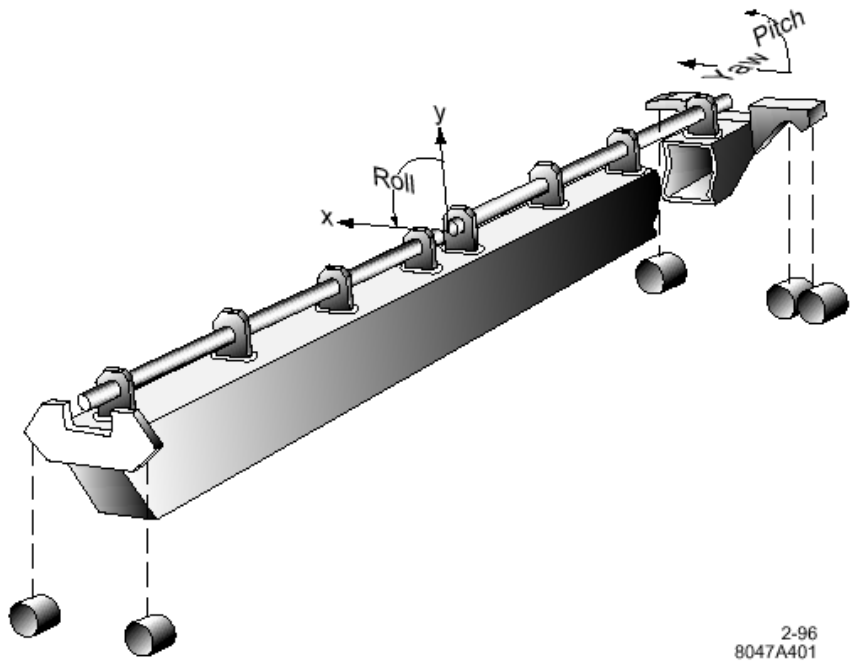
Work Accomplished: Girders

- Girders serve as the supporting bases for RF structures. They can be of the more simple box beam "strongback" design in use at the for NLC Test Accelerator (NLCTA) at SLAC, or a more complex design with a kinematic support system and multi-axis positioning capability.



Work Accomplished: Girders

- **5 degrees of freedom (x,y, pitch, roll, yaw)**
- **Range of motion +/- 1.5 mm**
- **Max travel per step 0.25μm**



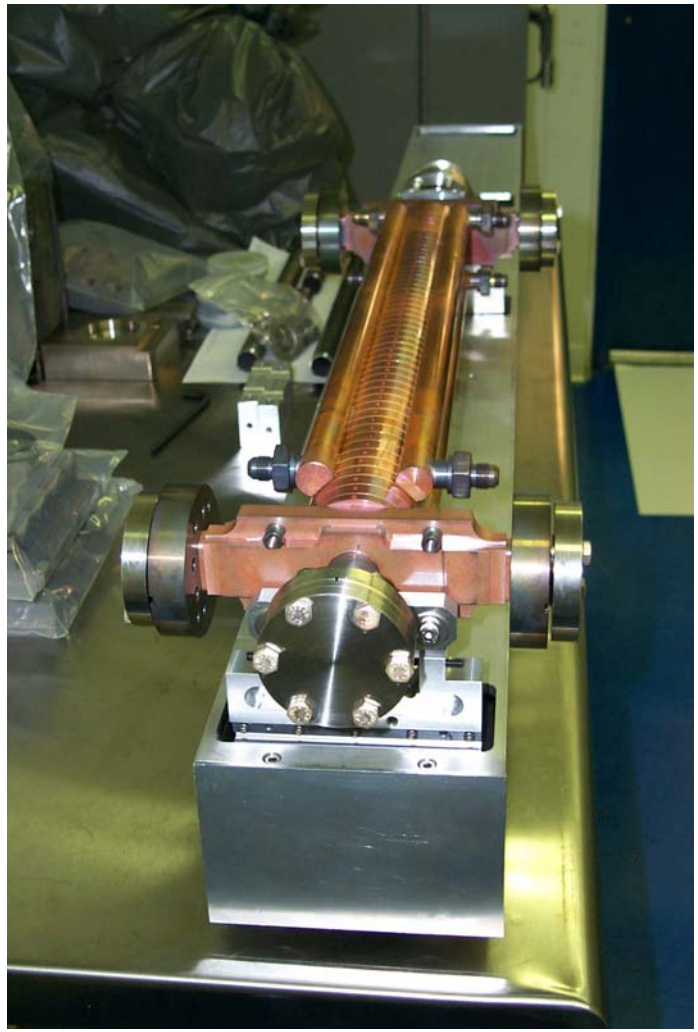
X-Y Roll

X-Z Yaw

Y-Z Pitch

Work Accomplished: Girders

A “Dummy” Structure being test fitted to a strongback



Work Accomplished: Girders

- Girders for FXB structures at NLCTA will remain the SLAC "Strongback" design, fabricated and assembled here at FNAL

FXB-002 mounted on NLCTA "Strongback"

Work Accomplished: Girder R&D

- We are just beginning to conduct girder tests, initially using a SLAC supplied test assembly.

SLAC Thermal Stability Test Girder in the MP8 Enclosure

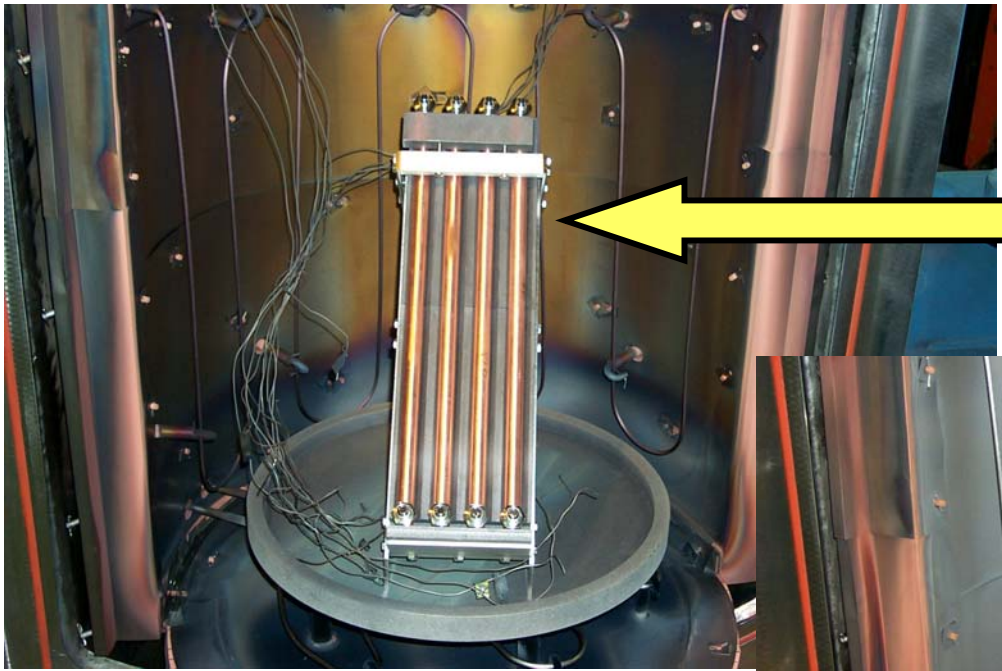
Work Accomplished: "Special" Projects

- DLDS (Delay Line Distribution System) Induction Brazing: We were assisting BD in this effort, as well as investigating other possibilities
- This project is on hold due to lack of funding and the decision to use the Sled II system rather than DLDS for the Eight Pack Project RF power distribution

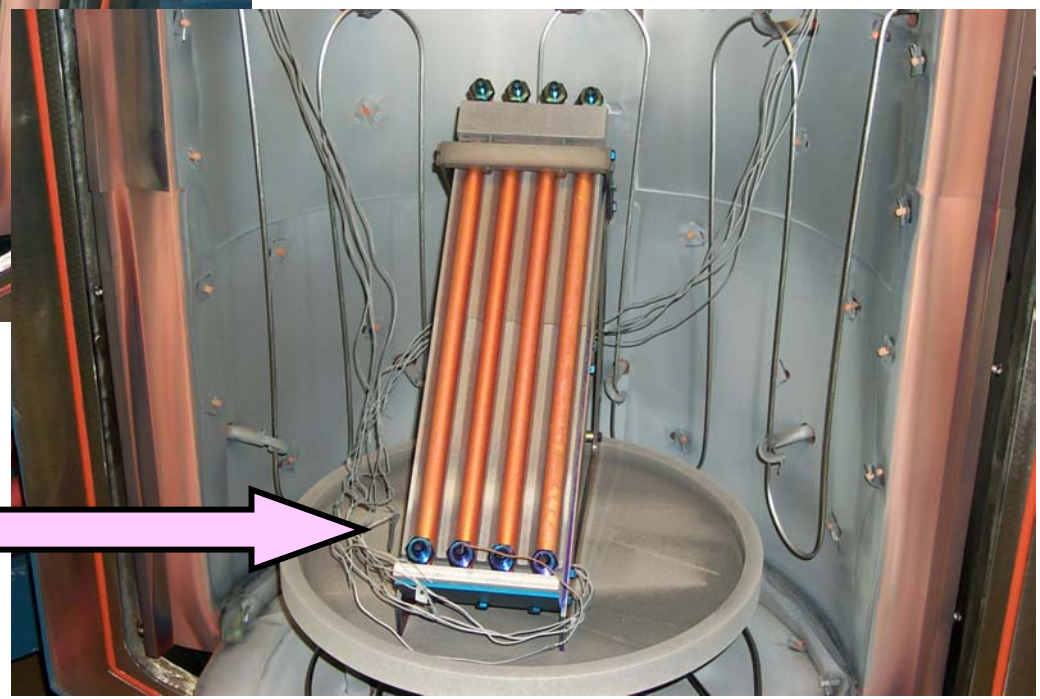
Work Accomplished: "Special" Projects

- **The AVS Large Vacuum Furnace has become a "special" project due to:**
  - Recurring air leaks resulting in interior components oxidation
  - Software/controls problems
  - Contamination of our product (structures) from the furnace interior
- **Our cooling water system has become another "special" project:**
  - Originally used the laboratory ICW system, but too much crud (both mud/silt and organic "critters")
  - We went to a closed loop, propylene glycol based cooling system, but we are still in the commissioning phase of that system and it is not yet reliable

Work Accomplished: AVS Large Vacuum Furnace



Water Tubes Before Brazing



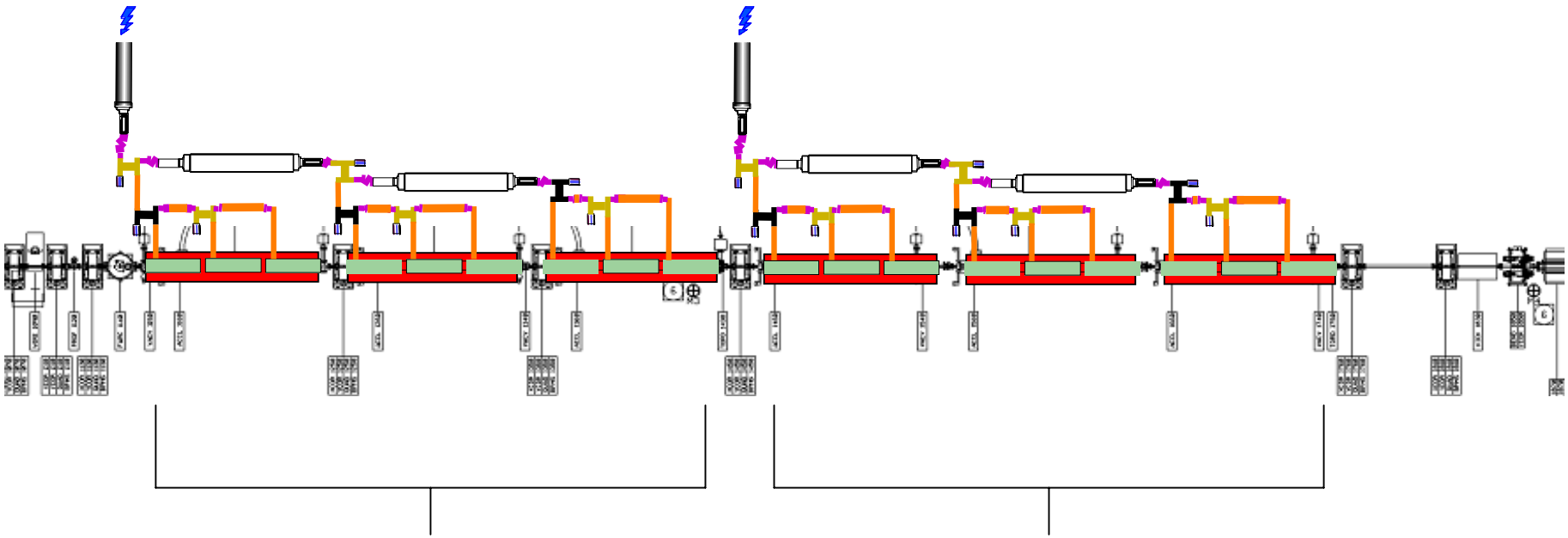
Water Tubes After Brazing

Future Plans: Structures for Eight Pack Test

- Eight Pack Test at SLAC (Dave Schultz, Project Manager)
  - In Phase II, a "pack of eight klystrons" will feed
    - 11.424 GHz X-Band power into a Sled II system and power at least 5.4 meters worth of structures with the full power and energy required by the NLC design.
  - The goal is to be operational by mid 2004

- Girder A System: Nine 0.6 m Long High Gradient Test Structures (FXBs, aka H60VG3)
- Girder B System: Six 0.75 m long NLC Main Linac Structures (FXCs, aka H75VG4S18)

The 8-Pack Test in NLCTA: Phase II



High Gradient Structures (FXBs)
On NLCTA-type Strongbacks
(Girder A)

NLC Prototype Structures (FXCs)
On NLCTA-type Strongbacks
(Girder B---Beyond Phase II)

Future Plans: NLC in TD for FY03

- For the remainder of FY03:
  - Complete FXB Structure Series (FXB-002 thru –006)
    - 60 cm long, conventional machined, brazed disk stack, high gradient, high phase advance (150 deg.), low group velocity (VG3), 61 mm OD
    - FNAL waveguide I/O coupler design
  - Begin FXC Structure Series Production (FXC prototype, then FXC-001 thru –005)
    - 75 cm long, conventional machined, diffusion bonded disk stack, high gradient, high phase advance (150 deg.), low group velocity (VG4), 61 mm OD
    - FNAL waveguide I/O coupler design

Future Plans: NLC in TD for FY03

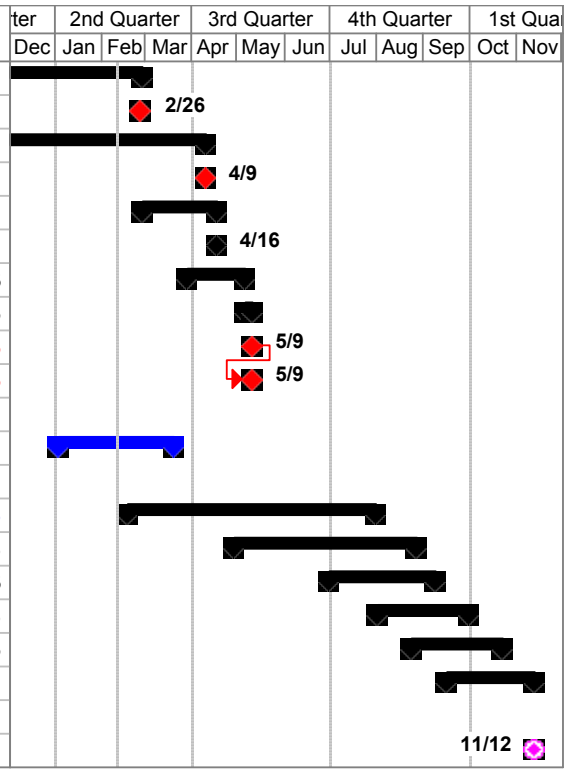
- **RF Design and Development**
  - Continue to improve measurement methods
  - Develop tuning of structures prior to final assembly
- **Girders**
  - Continue strongback production for NLCTA structures
  - Continue vibration and stability measurement and testing of structures and girders at MP8
- **"Special" Projects**
  - Get large vacuum furnace operating reliably and use it to facilitate structure production
  - Get water system operating reliably

Future Plans: NLC in TD

- **In FY03 (With flat funding, $1.8M):**
  - Build FXB-003 thru FXB-006 using FNAL-designed waveguide input and output couplers
  - Build FXC Prototype, then FXC-001 thru -005 (See how many we actually have in mid to late FY03 and decide what to do in FY04).
  - Develop NLC girder design and construct prototype for testing (vibration, stability, etc.) at FNAL with "dummy" structures, water cooling, vacuum, waveguide connections, HLS, movers, etc.
- **In FY04 (assuming flat funding once again): Continue the above, possibly including construction of an FXD series of structures.**

Production Schedule

ID	Task Name	Duration	Start	Finish
1	FXB-003 (Build with AVS furnace cooled by ICW)	89 days	Mon 10/21/02	Wed 2/26/03
24	FXB-003 Arrives at SLAC	0 days	Wed 2/26/03	Wed 2/26/03
25	FXB-004	99 days	Mon 11/18/02	Wed 4/9/03
56	FXB-004 Complete	0 days	Wed 4/9/03	Wed 4/9/03
57	FXB-005	35 days	Thu 2/27/03	Wed 4/16/03
86	FXB-005 Complete	0 days	Wed 4/16/03	Wed 4/16/03
87	FXB-006	27 days	Fri 3/28/03	Mon 5/5/03
117	Install FXB-004, -005, & -006 on Strongback	4 days	Tue 5/6/03	Fri 5/9/03
120	FXB-004 thru -006 Arrive at SLAC	0 days	Fri 5/9/03	Fri 5/9/03
121	FXB Series Production Complete	0 days	Fri 5/9/03	Fri 5/9/03
122				
123	Diffusion Bonding Tests	55 days	Thu 1/2/03	Wed 3/19/03
127				
128	FXC Prototype Structure (0.75 m, No HOM, FWG couplers)	117 days	Mon 2/17/03	Tue 7/29/03
162	FXC-001 (Contains All Features)	86.5 days	Mon 4/28/03	Tue 8/26/03
199	FXC-002	50.5 days	Mon 6/30/03	Mon 9/8/03
223	FXC-003	42.5 days	Fri 8/1/03	Tue 9/30/03
256	FXC-004	42.5 days	Fri 8/22/03	Tue 10/21/03
289	FXC-005	42.5 days	Mon 9/15/03	Wed 11/12/03
322				
323	All Structures for Phase II of Eight Pack Test Complete	0 days	Wed 11/12/03	Wed 11/12/03



Summary

- Delay in receipt of our large vacuum furnace impacted our structures production schedule but we met our FY02 plan. Operational/reliability problems with the large furnace once again threaten our schedule, but we intend to meet our FY03 plan.
- We are continually improving our RF testing and measurement capability in support of structure production.
- We continue to strengthen our structure and coupler design capability.
- Girder R&D work is in progress.
- Flat funding will remain a serious constraint on our (as well as the rest of the collaboration's) ability to accomplish our goals in a timely manner.

Tour and Web Site

- We are happy to conduct brief tours of our IB4 structure production facility --- just contact any of us.

- The pathway to our web site is:

  http://www-td.fnal.gov/lc/cv/lc.html

This talk as well as all others given by personnel in our group are posted on the site.